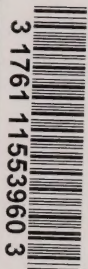


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Biotechnology at the Canadian
Forest Service

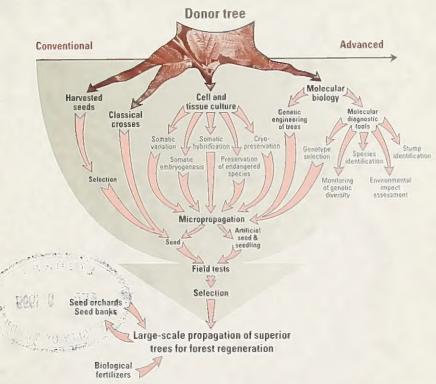


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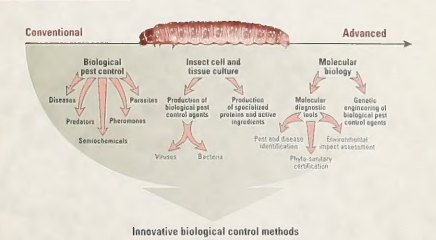
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Biotechnology Applications in the Forest Sector

Forest Regeneration



Forest Protection



Centres and Canadian Forest Service Networks

Atlantic Forestry Centre	Forest Health Network Manager	Tom Sternér	(506) 452-3506
	Forest Biodiversity Network Manager	Bruce Pendrel	(506) 452-3505
Laurentian Forestry Centre	Tree Biotechnology and Advanced Genetics Network Manager	Ariane Plourde	(418) 648-7616
	Forest Ecosystem Processes Network Manager	Denis Ouellet	(418) 648-5833
Great Lakes Forestry Centre	Pest Management Methods Network Manager	Errol Caldwell	(705) 759-5740
	Forest Ecosystem Processes Network Manager	Bill Meades	(705) 759-5740
Northern Forestry Centre	Fire Management Network Manager	Dennis Dubé	(403) 435-7205
	Climate Change Network Manager	Surj Malhotra	(403) 435-7201
	Socio-economic Research Network Manager	Steve Price	(403) 435-7206
Pacific Forestry Centre	Effects of Forestry Practices Network Manager	Gary Hogan	(250) 363-0705
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Biotechnology at the Canadian Forest Service

Innovation for the Regeneration and Protection of Canada's Forests in Support of Sustainable Forest Management



Natural Resources Canada
Canadian Forest Service

Ressources naturelles Canada
Service canadien des forêts

Canada

The Canadian Forest Service (CFS) is generating knowledge and exploring biotechnology applications to improve forest regeneration and protection methods, while ensuring that environmental impact considerations are addressed.

Biotechnology refers to the techniques through which organisms such as plants, fungi, or bacteria can be used to provide products or services.

Biotechnology research is conducted at CFS laboratories in the Pacific, Northern, Great Lakes, Laurentian, and Atlantic Forestry Centres. It is integrated nationwide through research networks, mainly the Pest Management Methods Network and the Tree Biotechnology and Advanced Genetics Network.

As the largest Canadian organization involved in forest biotechnology, the CFS also plays a key role in defining strategic research orientations, developing research partnerships, advising on regulations, developing skilled workers, increasing public awareness of forest biotechnology, and coordinating activities with industry, academia, and other governmental departments and agencies.

The biotechnology research supported by the CFS provides promising alternative tools that, in the context of sound forest management practices, will contribute to the ultimate goal of promoting the sustainable development of Canadian forests.



Research carried out by the CFS contributes to a better understanding of gene structure and function in conifers. The CFS is actively developing methods for the identification, development, and propagation of superior tree genotypes.

Core scientific expertise	Examples	Atlantic	Laurentian	Great Lakes	Northern	Pacific
Advanced Genetics Gene function and expression	- Time- and tissue-specific promoters, wood production genes, biotic and abiotic stress genes, flower sterility (spruce, balsam fir, white pine, poplar)					
Genetic vs environmental interactions	- White/Norway spruce, white pine					
Genetic structure	- Quantitative trait loci, wood density and quality (spruces), early performance ratings (white spruce), flower sterility (spruce)					
Genetic variability	- Black/white/Norway spruce, white pine, eastern yew					
Genetic selection	- Pest resistance (white pine, Norway/Sitka spruce, Douglas-fir)					
Plant-insect, plant-pathogen interactions	- Resistance mechanisms in white pine pathosystems with vesicular rust, gall rust, blister rust, and sclerodermis canker; Sitka spruce-white pine weevil interactions					
Molecular markers	- Development of markers as diagnostic, evaluation, early selection, and forensic tools (spruce, pine, maple)					
Genetic Engineering	- Spruce, white pine, poplar					
Cell and Tissue Culture Somatic embryogenesis/cryopreservation	- White/black spruce, white/jack/western white pine, larches, tamarack					
Developmental Biology/ Tree Physiology	- Differentiation (black spruce), dormancy (red/silver maple), seedling physiology (white spruce), hormone regulation (Scots pine, white spruce, balsam fir), production of secondary compounds (eastern yew)					
National Tree Seed Centre	- Collection, processing, testing, and storage of seed and germ plasm					

Forest Protection

Tree pests and diseases cause extensive losses in productivity, and weeds represent a challenge for the establishment of tree plantations. Effective pest management strategies are thus very important, and biotechnology can provide environmentally sound alternatives to chemical insecticides. The CFS is actively pursuing this area of research.

Core scientific expertise	Examples	Atlantic	Laurentian	Great Lakes	Northern	Pacific
Advanced Genetics Molecular characterization	- Viral, bacterial, and fungal pathogens of trees; baculoviruses					
Molecular markers	- Genes involved in sporulation (white pine blister rust, sclerodermis canker, root decay, seedling root rot), genes for resistance to pathogens and insect pests					
Gene expression	- Molting and metamorphosis genes (spruce budworm), genes for resistance to insects or pathogens					
Genetic Engineering	- Baculoviruses (early molting, markers)					
Insect Tissue Culture	- Cell lines of various species for basic research and the production of insect pest control products and bio-active molecules					
Developmental Biology/ Physiology Insect physiology	- Study of midgut tissue, developmental and reproductive physiology, hormonal control					
Biology of pathogens	- Biology of white pine blister rust, sclerodermis canker, elm vesicular wilt, blue stain of pine					
Biochemistry/ immunochemistry	- Study of insect hormonal metabolic disruptions, modes of action, protein and pheromone chemistry, identification and detection of insect pests					
Biological Control Agents Baculoviruses	- Against balsam fir sawfly, spruce budworm, Douglas-fir tussock moth, forest tent caterpillar larvae					
Microorganisms	- <i>Bacillus thuringiensis</i> , various insect pathogens					
Fungi	- Bioherbicides (against marsh reed grass, hard-wood weeds), competitors (against white pine blister rust, blue stain), pathogens (against insect pests)					
Parasitoids/nematodes	- Against yellowheaded spruce sawfly, spruce budworm, eastern hemlock looper, cone maggots, white pine weevil, gypsy moth					
Natural Products Pheromones	- Against yellowheaded spruce sawfly, spruce budworm, eastern hemlock looper					
Other semiochemicals	- Insecticidal piper alkaloids, neem (azadirachtin), growth regulators					
Spread Rate Model	- Armillaria root decay, seedling root rot					

Environmental Impact and Deployment Studies



Before any biotechnology-derived product can be released into the environment, a thorough environmental safety assessment must be performed. The CFS is actively developing protocols for science-based evaluations of potential environmental impacts.

Core scientific expertise	Examples	Atlantic	Laurentian	Great Lakes	Northern	Pacific
Trees Stand management/ deployment studies	- Douglas-fir, western hemlock, white/Norway spruce, white pine					
Conservation strategies	- Stochastic tree population simulator (POPSIM)					
Monitoring protocols	- White/bur oak, red/black spruce, white pine					
Field trials	- Using genetic markers (white/red/black spruce, red/silver maple, white pine)					
Biological Pest Control Agents	- Stability and safety of genetically engineered poplars and conifers, ecological interactions					
Study of host range, infectivity, and toxicity	- Development of safety assessment tools for biological control agents, using microcosms (aquatic and terrestrial) and bioassays					
Monitoring protocols	- Diagnostic tools for pathogen identification, study of environmental fate					
Field trials	- Efficacy and safety of biological control agents, ecological interactions					



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